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EMBRYOLOGY.<sup>1</sup>

**Gastrulation of Aurelia.**<sup>2</sup>—Frank Smith has entered into the controversy between Claus and Goette concerning the origin of the entoblast of Aurelia. The results obtained from his first sections led him to think that the conclusions reached by Goette for *Aurelia aurita* would be confirmed in the case of *A. flavidula*. Better staining, thinner sections and more accurate orientation have, however, made it certain that the gastrulation in this species is much more in accord with the description given by Claus and that the process really is one of invagination. The result of cleavage is a one-layered blastosphere as in *A. aurita*. The cells of the blastosphere are usually somewhat shorter at one pole than elsewhere, and it is from this region that the entoblast is formed. It develops as a single continuous layer of cells surrounding a small cavity, the coelenteron. From the beginning there is a narrow blastopore. Only a small portion of the wall of the blastosphere is concerned in the invagination, and to that extent it is not typical. The coelenteron is, however, at all stages, an open sac-like cavity, and therefore noticeably different from that of *A. aurita* as described by Claus. The coelenteron enlarges until the cleavage cavity is entirely obliterated and the entoblast everywhere comes into contact with the ectoblast. The entoblast, at first thin, thickens after the completion of gastrulation.

While the entoblast is formed by invagination, ingression of cells from the wall of the blastosphere into the cleavage cavity does occur, although only in a minority of cases. It may happen any time after the blastosphere contains about 100 cells, sometimes before invagination. When this phenomenon takes place it is similar to that represented by Goette (Figs. 1–5) for the earlier stages of the blastula in *A. aurita*, and consists of the migration into the cleavage cavity of one or two, rarely more than three, of the cells of the blastospheric wall. Soon after invagination the nucleus of the cell disappears and the cell breaks down, or, less frequently, persists until gastrulation is complete. In the latter case it becomes forced through the entoblastic wall into the cavity of the coelenteron. The cause or purpose of this immigration does not appear.

<sup>1</sup>This department is edited by Dr. E. A. Andrews, Johns Hopkins University.

<sup>2</sup>Bull. Mus. Comp. Zool., Harvard, xxii.

The author thinks that the difference in opinion between Claus and Goette is partially due to there being two kinds of cells that find their way into the cleavage cavity. Besides the large cells just described he found in a much smaller number of cases one or two very small cells that look precisely like the small cells that appear in the deeper part of the ectoblast at about the time gastrulation begins.

There is no evidence that the immigrating cells have anything to do with the formation of the entoblast, and Goette's case is further weakened by the fact that all the conditions shown in his figures (6-9) can easily be reproduced from sections of invaginating gastrulæ of a single stage of development.

**Cleavage in *Aequoria Forskalea*.**—Dr. V. Hæcker<sup>3</sup> contributes an interesting series of observations on this subject. He finds that when the specimens are in good condition the time relations between the successive periods of activity are remarkably precise.

If ripe, the eggs are laid between 7 and 7.30 A. M. The first polar body is extruded at 9 A. M. The entrance of the spermatozoan and the division to form the second polar nucleus takes place at 9.30. At 10 A. M. the dyaster stage of the first cleavage nucleus occurs, and with it the first indication of the division of the cell body. The daughter nuclei are undergoing metakinesis at 11, and at 12 the four nuclei of the next set are in the dyaster stage. The nuclear divisions continue to take place an hour apart at least as far as the sixty-four cell stage, and this seems to show that the nucleus is not affected at this period by the amount of cell protoplasm that it controls. Normally nuclear division takes place at the same time throughout the egg, and the blastomeres are of equal size up to the sixty-four-cell stage.

When eggs are laid after the specimen has been kept in an aquarium several days, irregularities generally occur in the time of nuclear division and in the size of the blastomeres. At the same time a pathological form of nuclear division, the triaster, appears, and the mass of cells loses its spherical shape.

A remarkable feature of the cleavage of the egg of *Aequoria* is the presence of a body for which the author proposes the name *Metanucleolus*. In the older ovarian eggs and in eggs just laid there is a large nucleus containing a very fine network of chromatin and a large spherical or reniform nucleolus. About half an hour after the egg is laid this nucleolus appears to have been extruded, for the nucleus is now much smaller than it was and has no nucleolus, while in the egg

<sup>3</sup>Archiv. fur Mikro. Anat., 40 Bd., 2 Heft.

outside of the nucleus but close to it there is a body resembling the former nucleolus in every particular, except position. This body, the metanucleolus, never divides, there is never any radial arrangement of the protoplasm about it, and it may be found in one of the blastomeres until a later stage in the cleavage. From a review of the work of Metschnikoff, Boveri, and others, the author thinks that homologous structures have been seen, although wrongly interpreted, in the *Leptomedusæ*, *Anthomedusæ*, *Siphonophores* and apparently also in *Mytilus* and *Sagitta*. He has also examined Weismann and Ischikawa's preparations of the winter eggs of *Daphnids*, with the result that he regards the paracopulation cells as not cells at all, but as in all probability structures homologous with the metanucleoli of the medusæ.

Another point of interest in this paper is the numerical relation between the chromosomes of the second polar spindle and of the first cleavage spindle, there being six in the former and twelve in the latter. Boveri had pointed out that in the forms in which this point had been studied, while the number varied in different species, the number of chromosomes in the cleavage spindle was always just double the number in the last polar spindle, and he had also noticed that the number of the latter in certain species could be arranged in a geometrical series in which the numbers are forms of two (2, 4, 8, 16, 32). Hæcker reviews the literature of the subject and shows that there may be two other series besides this one. There is a series of the forms of three (3, 9, 27, etc.), of which, however, there is but one example, *Echinus* with nine chromosomes, and then there is a mixed double and triple system (6, 12, 18, 24, 36, 48, etc.), to which *Aequoria* belongs, as well as the greater part of the insects and the vertebrates. He concludes that all cases so far known may be arranged in three systems in such a way that in general nearly related forms belong to the same system.

R. P. BIGELOW.

- (1) *Zeit. f. Wiss. Zool.*, 49, 1890, pp. 503-580, plates 24-26.
- (2) *Zeit. f. Wiss. Zool.*, 51, 1891, pp. 685-730, plates 35-37.
- (3) *Zeit. f. Wiss. Zool.*, 54, 1892, pp. 1-249, plates 1-12.